



**US Army Corps
of Engineers**
Waterways Experiment
Station

Preliminary Data Summary January 1998 Field Research Facility

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Contents

1	Introduction	1
2	Meteorological Data	5
3	Wave Data	10
4	Current Data	15
5	Visual Observations	18
6	Water Levels	20
7	Bathymetry	22
8	Special Events	25

List of Figures

No.

1	FRF Location Map	1
2	Month at a Glance	2
3	Instrument Locations at FRF	4
4	Meteorological Monthly Summary	6
5	Wave Heights and Periods	14
6	Water Levels	20
7	CRAB Profiles	22
8	CRAB Profile Envelope	23
9	FRF Bathymetry (12 January 98)	24

List of Tables

No.

1	Instrument Status/Data Availability	3
2	Gauge Locations	4
3	Meteorological Data	7
4	Wave Data	11
5	Current Meter Data	16
6	Visually Observed Current Data	17
7	Visual Observations	19
8	Water Levels	21

1 Introduction

The U.S. Army Corps of Engineers Waterways Experiment Station, Coastal and Hydraulics Laboratory (CHL), Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. Central to the FRF is the research pier, a reinforced concrete structure which extends from behind the duneline to about the 6-m water depth contour at a height of 7.75 m above the NGVD (1929 National Geodetic Vertical Datum).

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local bathymetric, oceanographic, and meteorological conditions. This is a preliminary which provides basic data soon after collection. Since they are preliminary further quality control may be applied to the data and made available via the internet at <http://www.frf.usace.army.mil>. Questions and/or comments concerning the data may be directed to Mr. Clifford F. Baron at (919)261-6840 ext.222 (c.baron@cerc.wes.army.mil).

Chapter 2 presents the meteorological data; Chapters 3 through 6 present oceanographic data; Chapter 7 presents nearshore profiles and bathymetry; and Chapter 8 documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used and their operational status during the month. Figure 2 shows weather and ocean conditions for the month. Table 2 and Figure 3 identifies the location of the instruments. The water depths at the wave gauges and current meters vary and may be determined from information contained in Figure 9. Other installation information is contained in Table 2.

Times given in the report are referenced to eastern standard time (EST).



Figure 1. FRF Location Map

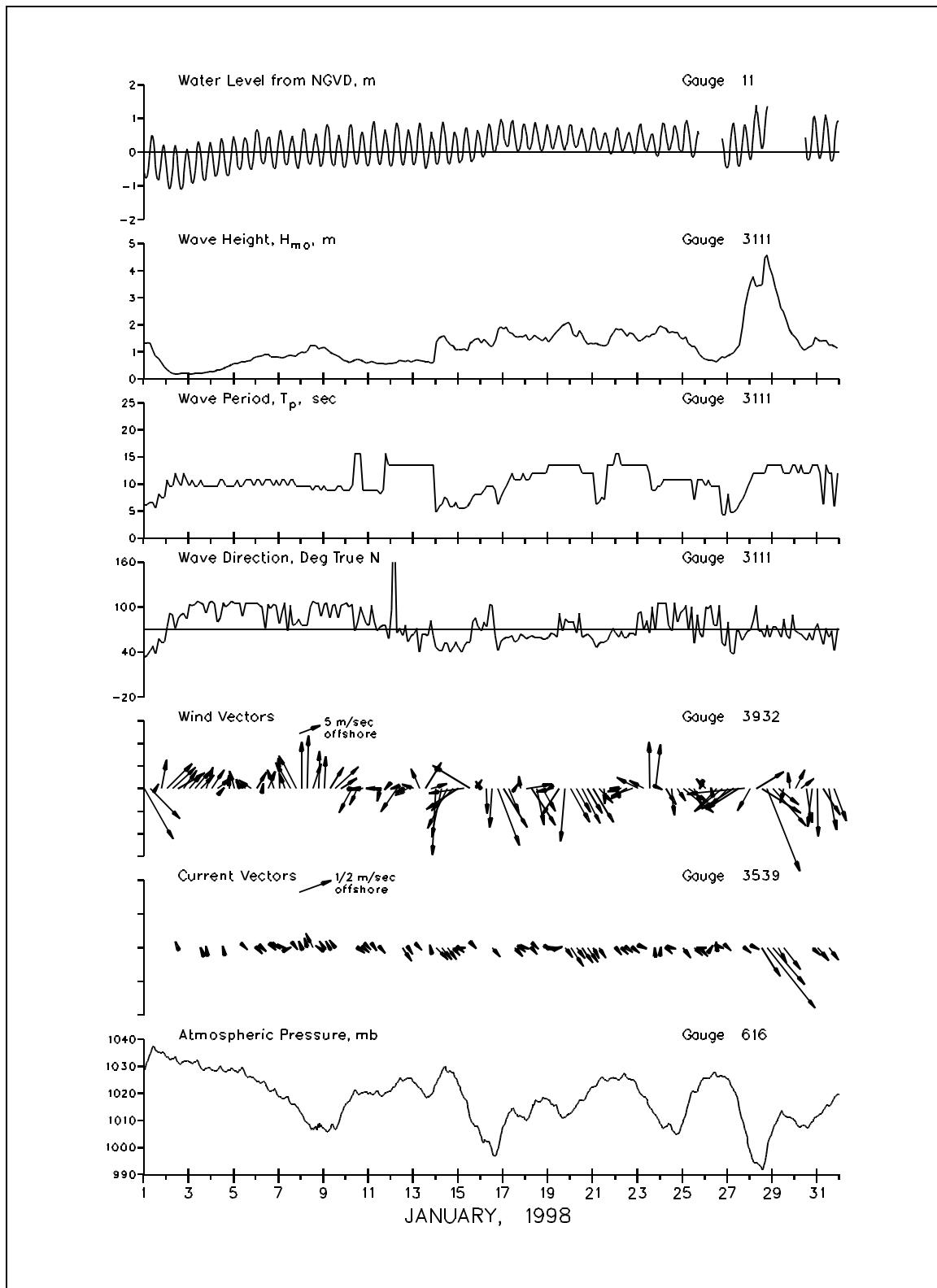


Figure 2. Month at a Glance

Table 1
Instrument Status/Data Availability

Table 2 Gauge Locations

Gauge ID	Description	Latitude Degrees N	Longitude Degrees W	FRF Coordinates Crossshore Longshore m m	Gauge Depth NGVD, m	Water Depth NGVD, m
616	Atmospheric Pressure	36 10' 57.03"	75 45' 5.50"	11.60	569.00	-----
3932	Anemometer	36 11' 1.23"	75 44' 43.07"	585.20	517.30	19.50
641	Pressure Gauge	36 10' 57.71"	75 44' 56.23"	239.11	516.64	-1.64
625	Baylor Staff	36 11' 1.04"	75 44' 43.72"	568.00	516.64	Surface
3111	8 Meter Array North	36 11' 19.14"	75 44' 36.41"	915.23	990.16	-7.50
	8 Meter Array South	36 11' 11.28"	75 44' 33.28"	914.20	735.37	-7.42
	8 Meter Array East	36 11' 13.70"	75 44' 32.56"	954.51	800.58	-7.62
	8 Meter Array West	36 11' 12.48"	75 44' 37.11"	834.66	800.37	-6.98
111	Pressure Gauge in center of 8 M Array	36 11' 14.06"	75 44' 34.39"	914.43	825.52	-7.76
630	Waverider Buoy	36 10' 5.10"	75 41' 59.30"	3934.96	-2400.81	Surface
3539	Current Meter	36 11' 23.57"	75 44' 9.12"	1605.80	907.60	-11.60
11	NOAA Tide Gauge	36 11' 1.25"	75 44' 42.60"	596.49	514.20	Surface
						-7.62

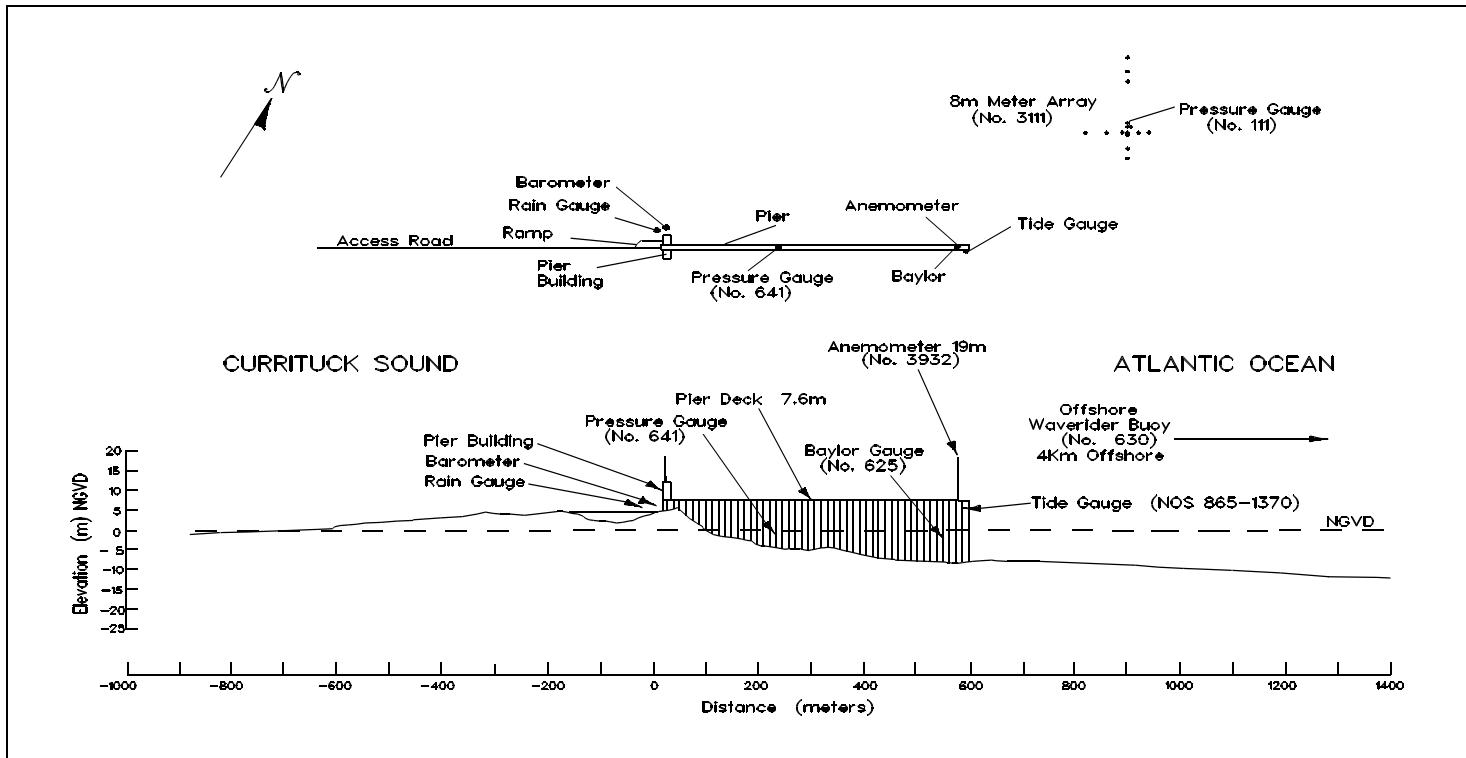


Figure 3. Instrument Locations, Elevations From NGVD

2 Meteorological Data

A variety of instruments have been installed at the FRF (Figure 3) to monitor the meteorological conditions. The data presented in Table 3 are collected and stored using a Digital Equipment Corporation VAXstation 4000. For each instrument identified in Table 1, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m using a WeatherMeasure Skyvane anemometer. Monthly resultant wind speeds and directions (Figure 4) are determined by vector averaging the data. Wind directions (Table 3) indicate where the wind is coming from. Temperature and atmospheric pressure means (Table 3) are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 3 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -
 $mm \times .03937 = in.$
2. Millibars (mb) to inches of mercury (in. Hg) -
 $mb \times 0.02953 = in. Hg$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -
 $(C \times 9/5) + 32 = F$
4. Meters per second (m/s) to knots (kn) -
 $m/s \times 1.943 = kn$

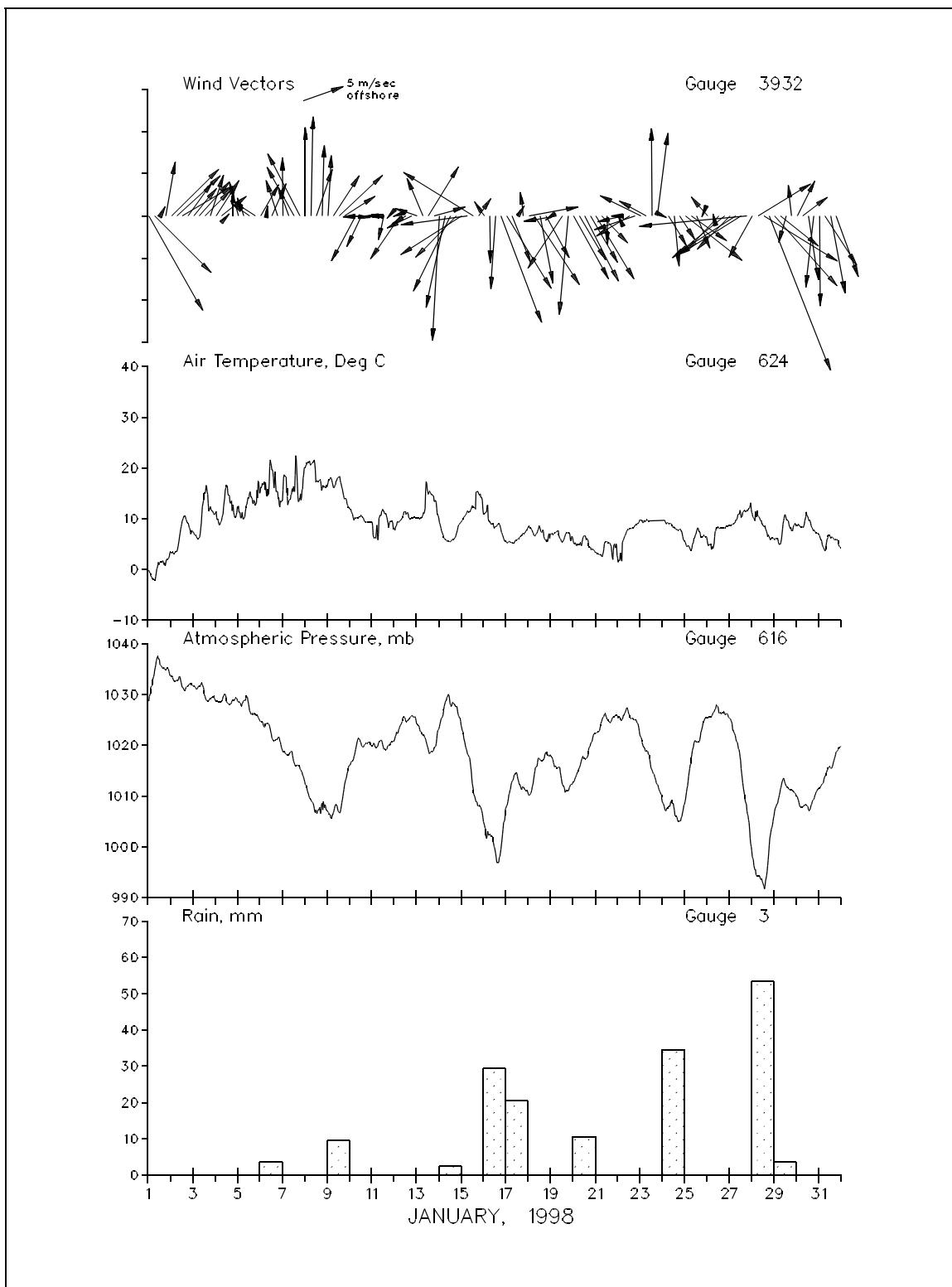


Figure 4. Meteorological Monthly Summary

Table 3
Meteorological Data

Jan 1998						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	13	330	-0.2	1028.8	0
	700	9	315	-2.1	1034.8	0
	1300	1	209	1.4	1036.0	0
	1900	6	189	1.3	1035.1	0
2	100	8	225	3.2	1033.7	0
	700	7	227	3.6	1032.8	0
	1300	7	239	9.6	1031.5	0
	1900	5	215	9.1	1031.7	0
3	100	4	219	7.1	1031.7	0
	700	5	221	6.3	1031.8	0
	1300	4	225	15.0	1029.7	0
	1900	5	197	12.4	1029.3	0
4	100	5	212	11.4	1028.7	0
	700	4	231	9.5	1028.7	0
	1300	0		16.5	1028.4	0
	1900	3	180	12.7	1028.9	0
5	100	4	164	12.5	1028.5	0
	700	2	159	10.0	1028.9	0
	1300	3	124	15.0	1026.9	0
	1900	3	124	12.9	1026.2	0
6	100	4	209	16.2	1024.7	0
	700	1	188	14.5	1024.3	4
	1300	4	203	19.6	1021.6	0
	1900	4	162	15.2	1021.4	0
7	100	7	179	15.6	1018.7	0
				13.5	1018.1	0
	1300	inoperative		15.5	1016.6	0
	1900			13.9	1015.5	0
8	100	10	179	20.1	1012.4	0
	700	12	181	20.7	1009.2	0
	1300	6	198	17.5	1007.0	0
	1900	8	181	16.0	1008.6	0
9	100			17.1	1006.9	0
	700	6	212	16.2	1006.8	10
	1300	7	227	18.2	1006.8	0
	1900	inoperative		13.8	1012.3	0
10	100			11.8	1016.2	0
	700	6	28	10.0	1019.3	0
	1300	4	25	10.4	1020.1	0
	1900	3	87	9.4	1020.5	0

Table 3
Meteorological Data (continued)

Jan 1998						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
11	100	1	89	8.6	1020.0	0
	700	1	100	5.8	1020.0	0
	1300	3	12	11.5	1019.3	0
	1900	0		9.2	1020.2	0
12	100	0		7.7	1021.4	0
	700	6	34	9.7	1023.9	0
	1300	2	60	10.8	1024.7	0
	1900	3	63	10.1	1025.9	0
13	100	3	108	10.1	1024.2	0
	700	5	157	10.7	1022.0	0
	1300	7	211	14.8	1019.2	0
	1900	4	254	13.5	1019.6	0
14	100	15	3	9.3	1023.7	0
	700	11	11	5.9	1028.5	2
	1300	10	26	5.5	1028.0	0
	1900	7	44	7.1	1027.8	0
15	100	9	57	9.5	1023.5	0
	700	8	82	11.5	1018.3	0
	1300	10	121	12.3	1011.3	0
	1900	3	215	14.9	1008.2	0
16	100	2	145	10.9	1004.3	0
	700	6	359	9.3	1002.4	29
	1300	9	3	8.6	998.8	0
	1900	13	339	7.8	999.6	0
17	100	10	328	5.4	1008.1	0
	700	6	338	5.2	1013.0	21
	1300	1	212	6.0	1013.4	0
	1900	inoperative		7.1	1011.8	0
18	100	6	259	8.5	1010.2	0
	700	10	326	6.6	1014.4	0
	1300	8	349	8.1	1017.2	0
	1900	6	330	5.7	1018.7	0
19	100	1	54	7.0	1017.8	0
	700	4	80	7.5	1015.5	0
	1300	7	33	5.4	1012.3	0
	1900	12	5	7.2	1011.1	0
20	100	inoperative		5.2	1012.8	0
	700	6	329	5.0	1015.7	11
	1300	9	332	6.5	1017.4	0
	1900	6	329	4.3	1020.3	0

Table 3
Meteorological Data (concluded)

Jan 1998						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
21	100	9	329	3.3	1022.4	0
	700	4	316	2.6	1024.8	0
	1300	3	359	5.5	1025.2	0
	1900	0		1.9	1025.6	0
22	100	0		1.4	1025.4	0
	700	3	77	6.1	1025.9	0
	1300	inoperative		8.0	1025.9	0
	1900	5	71	8.7	1025.0	0
23	100	5	116	9.7	1021.6	0
	700	4	119	9.5	1018.9	0
	1300	10	179		1015.1	0
	1900	10	187	nop	1012.3	0
24	100	0			1008.6	0
	700	4	329	9.1	1008.0	34
	1300	6	354	8.1	1007.4	0
	1900	3	327	7.9	1005.2	0
25	100	9	308	5.3	1009.3	0
	700	5	304	3.6	1016.5	0
	1300	4	337	7.5	1020.7	0
	1900	0		6.3	1023.8	0
26	100	3	138	5.1	1025.5	0
	700	inoperative		4.2	1026.4	0
	1300	6	42	8.1	1026.4	0
	1900	8	51	8.1	1026.4	0
27	100	6	44	8.6	1025.3	0
	700	8	57	9.7	1021.3	0
	1300	9	58	10.3	1015.4	0
	1900	13	84	11.7	1007.1	0
28	100	6	29	10.9	998.1	0
	700	7	238	10.5	994.3	53
	1300	10	301	8.5	992.2	0
	1900	20	338	6.5	1000.3	0
29	100	11	318	5.8	1007.0	0
	700	6	308	5.0	1011.4	3
	1300	3	15	10.0	1012.1	0
	1900	4	174	7.6	1011.2	0
30	100	5	206	8.6	1009.9	0
	700	4	232	8.3	1007.9	0
	1300	8	351	9.9	1007.3	0
	1900	9	6	7.7	1009.4	0
31	100	11	359	6.7	1011.6	0
	700	7	327	3.6	1014.0	0
	1300	9	349	6.1	1015.5	0
	1900	8	340	5.8	1018.7	0
		Resultant		Mean	Mean	Total
		1	344	9.1	1018.1	167

3 Wave Data

Wave data are collected from three different sets of instruments, as shown in Table 1 and Figure 3. The first is an array of fifteen pressure gauges, collectively referred to as gauge 3111 (gauge 111 being one of them). Directional information is computed from these gauges using an iterative maximum likelihood estimator. The second is a Baylor staff gauge (625) and a pressure gauge (641), both attached to the pier. The third is a Waverider buoy (630). The data are collected, analyzed, and stored on optical disc using a Digital Equipment Corporation VAXstation 4000. Data is sampled at 2 Hertz, with five contiguous 34 minute records, for a total collection period of nearly 2 hours and 51 minutes. This report reflects the data collection periods of 0100, 0700, 1300, and 1900 EST. The results are based only on the first 34 minute record. The exception is the 8 Meter Array (3111) which condenses the first four records into one statistical value.

Wave height H_{mo} is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gauge has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 degrees of freedom calculated from a 34-min record. Peak wave period T_p is defined as the period associated with the maximum energy in the spectrum.

Table 4 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 4 are average values computed from this data. Figure 5 is a time history of all H_{mo} and T_p values obtained for all gauges.

Differences in wave periods between wave gauges (Table 4 and Figure 5) may be the result of wave breaking, wave reformation, the presence of multiple wave trains containing nearly equal energy, and statistical variations in spectral estimations.

Table 4
Wave Data

Jan 1998											
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider		
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec	
1	0100	0.90	6.0	1.21	5.7	1.35	6.2	34	1.59	5.3	
	0700	1.22	6.1	1.22	6.1	1.32	6.6	42	1.66	6.3	
	1300	0.81	5.4	0.84	5.9	0.85	5.6	38	1.20	6.3	
	1900	0.52	7.0	0.65	7.8	0.62	7.6	54	1.01	7.7	
2	0100	0.22	7.3	0.40	9.2	0.34	10.8	74	0.60	10.6	
	0700	0.12	10.7	0.22	11.7	0.22	9.8	90	0.44	9.1	
	1300	0.12	12.2	0.19	10.3	0.19	10.8	84	0.48	11.2	
	1900	inoperative		0.25	11.7	0.21	12.0	92	0.29	10.6	
3	0100			0.22	11.7	0.20	9.8	104	0.30	10.1	
	0700	0.13	9.5	0.20	10.7	0.21	9.8	104	0.33	11.2	
	1300	0.14	4.2	0.23	10.3	0.22	10.8	106	0.28	10.1	
	1900	0.14	9.5	0.28	9.2	0.26	9.8	92	0.34	10.1	
4	0100	0.17	9.2	0.27	9.9	0.27	9.8	108	0.32	10.6	
	0700	0.15	9.5	0.31	9.5	0.34	9.8	80	0.34	10.1	
	1300	0.23	10.3	0.34	10.7	0.38	10.8	106	0.42	10.1	
	1900	0.22	10.3	0.43	9.9	0.48	9.8	104	0.50	10.1	
5	0100	0.33	9.9	0.53	9.5	0.58	9.8	106	0.66	10.6	
	0700	0.32	10.7	0.57	10.3	0.62	9.8	106	0.77	10.1	
	1300	0.41	9.9	0.63	9.9	0.66	10.8	106	0.74	10.1	
	1900	0.37	10.7	0.66	9.9	0.70	10.8	106	0.83	11.2	
6	0100	0.54	10.7	0.79	10.3	0.82	10.8	106	1.00	10.6	
	0700	0.55	6.5	0.84	9.5	0.86	9.8	100	1.04	10.1	
	1300	0.59	11.2	0.88	9.5	0.92	10.8	104	1.12	10.6	
	1900	0.42	10.7	0.71	10.7	0.82	9.8	104	0.97	9.1	
7	0100	0.53	10.7	0.77	10.3	0.81	9.8	78	0.99	10.6	
	0700	0.44	10.7	0.73	10.7	0.81	10.8	106	0.92	10.1	
	1300	0.58	9.5	0.85	9.9	0.88	10.8	102	1.08	10.1	
	1900	0.51	10.7	0.82	10.7	0.84	9.8	78	0.98	10.1	
8	0100	0.66	9.9	0.94	9.9	1.01	9.8	76	1.15	10.1	
	0700	0.61	10.3	0.85	9.9	1.02	9.8	76	1.13	10.1	
	1300	0.83	9.5	1.07	9.5	1.22	8.9	108	1.47	8.4	
	1900	0.85	9.5	1.06	9.5	1.11	9.8	106	1.41	10.6	
9	0100	0.83	9.5	1.07	8.9	1.17	9.8	104	1.24	10.1	
	0700	0.76	9.5	1.03	9.5	1.01	8.9	86	1.21	9.1	
	1300	0.59	9.2	0.85	9.2	0.91	8.9	104	1.06	9.1	
	1900	0.53	9.9	0.73	9.5	0.77	9.8	102	0.83	10.1	
10	0100	0.39	9.2	0.62	9.2	0.67	8.9	106	0.79	9.1	
	0700	0.46	9.2	0.62	9.5	0.66	9.8	104	0.77	10.1	
	1300	0.49	3.9	0.67	15.1	0.74	15.7	80	0.85	9.1	
	1900	0.47	4.7	0.66	9.5	0.65	8.9	90	0.79	9.1	

Table 4
Wave Data (continued)

Jan 1998										
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider	
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
11	0100	0.39	16.0	0.57	9.2	0.62	8.9	76	0.68	8.4
	0700	0.41	9.2	0.58	8.3	0.61	8.9	80	0.66	8.4
	1300	0.28	8.1	0.54	8.6	0.58	8.2	74	0.60	7.7
	1900	0.34	15.1	0.52	14.3	0.56	15.7	76	0.62	15.4
12	0100	0.28	14.3	0.56	14.3	0.58	13.6	96	0.56	15.4
	0700	0.43	15.1	0.59	14.3	0.62	13.6	66	0.70	13.4
	1300	0.39	13.5	0.62	13.5	0.67	13.6	62	0.76	13.4
	1900	0.49	13.5	0.67	13.5	0.68	13.6	54	0.76	13.4
13	0100	0.42	13.5	0.61	13.5	0.67	13.6	64	0.73	12.6
	0700	0.49	12.9	0.67	12.9	0.70	13.6	40	0.79	13.4
	1300	0.31	13.5	0.61	12.9	0.65	13.6	64	0.84	13.4
	1900	0.35	12.9	0.56	12.9	0.59	13.6	82	0.64	13.4
14	0100	0.88	4.7	1.09	4.7	1.35	4.8	46	1.16	4.1
	0700	1.38	6.3	1.52	6.3	1.58	6.2	42	2.04	5.9
	1300	0.94	6.1	1.30	6.6	1.38	7.1	52	1.60	6.3
	1900	1.07	5.7	1.18	5.6	1.23	5.9	46	1.36	5.6
15	0100	0.79	4.8	1.10	6.5	1.09	5.6	46	1.34	5.3
	0700	0.80	5.5	1.09	5.5	1.11	5.6	48	1.38	5.9
	1300	0.73	7.0	1.25	6.3	1.32	6.6	54	1.46	5.6
	1900	0.94	8.1	1.27	7.4	1.48	8.2	86	1.71	7.7
16	0100	0.88	8.6	1.31	8.9	1.33	8.2	68	1.54	9.1
	0700	0.91	9.5	1.31	9.5	1.37	9.8	74	1.64	10.1
	1300	0.73	9.5	1.08	9.9	1.22	9.8	102	1.35	9.1
	1900	1.25	6.0	1.52	6.0	1.83	6.2	42	1.91	5.3
17	0100	1.36	8.3	1.85	8.3	1.85	8.9	58	2.12	8.4
	0700	1.25	10.7	1.72	10.7	1.73	10.8	60		
	1300	1.13	11.7	1.38	11.7	1.58	10.8	54		
	1900	1.09	11.2	1.45	11.2	1.58	10.8	64		
18	0100	1.17	10.7	1.53	11.2	1.63	10.8	58		
	0700	1.01	11.7	1.30	11.7	1.49	12.0	62		
	1300	1.13	11.2	1.38	12.2	1.54	12.0	60		
	1900	0.98	12.2	1.38	12.2	1.43	12.0	58	inoperative	
19	0100	1.05	12.9	1.33	12.9	1.37	13.6	60		
	0700	1.01	14.3	1.34	12.9	1.61	13.6	64		
	1300	1.21	13.5	1.62	13.5	1.84	13.6	92		
	1900	1.08	14.3	1.88	13.5	2.04	13.6	84		
20	0100	1.25	13.5	1.91	13.5	1.97	13.6	80		
	0700	0.89	13.5	1.46	13.5	1.55	13.6	66		
	1300	1.13	12.9	1.57	12.9	1.64	12.0	60		
	1900	0.84	12.2	1.31	12.2	1.30	12.0	64		

Table 4
Wave Data (concluded)

Jan 1998										
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider	
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
21	0100	1.00	6.1	1.27	12.2	1.31	12.0	56		
	0700	0.87	6.1	1.17	6.5	1.26	6.6	52		
	1300	0.97	7.8	1.12	7.0	1.23	7.1	54		
	1900	0.89	13.5	1.25	12.9	1.53	13.6	64		
22	0100	1.25	13.5	1.76	13.5	1.86	15.7	66		
	0700	1.15	14.3	1.62	14.3	1.84	13.6	68		
	1300	1.02	15.1	1.36	13.5	1.57	13.6	60		
	1900	0.91	14.3	1.50	13.5	1.68	13.6	66		
23	0100	0.98	12.9	1.33	12.9	1.43	13.6	92		
	0700	0.93	13.5	1.47	12.9	1.49	13.6	70		
	1300	1.01	7.6	1.43	12.9	1.55	12.0	66	inoperative	
	1900	0.98	8.6	1.56	8.9	1.68	8.9	70		
24	0100	1.12	10.3	1.89	9.9	1.96	9.8	106		
	0700	1.09	10.3	1.75	11.2	1.87	10.8	106		
	1300	0.96	9.9	1.49	10.7	1.75	10.8	68		
	1900	0.96	11.2	1.57	10.7	1.73	10.8	80		
25	0100	0.98	5.4	1.38	10.7	1.48	10.8	96		
	0700	0.94	6.8	1.34	10.7	1.31	10.8	70		
	1300	0.76	7.0	1.13	11.2	1.20	7.1	52		
	1900	0.61	6.5	0.78	6.8	0.89	10.8	66		
26	0100	0.37	17.1	0.64	9.5	0.73	9.8	100		
	0700	0.42	10.3	0.70	10.3	0.70	9.8	102		
	1300	0.39	5.1	0.61	9.5	0.64	9.8	76		
	1900	0.47	4.2	0.84	4.2	0.83	4.4	52	1.05	10.1
27	0100	0.51	4.6	0.84	8.6	0.87	8.2	80	0.93	10.1
	0700	0.63	4.5	0.96	4.4	0.98	4.8	38	1.09	4.8
	1300	0.57	5.0	1.14	5.7	1.23	6.2	68	1.37	5.9
	1900	1.17	9.2	2.17	8.9	2.70	8.2	62	2.46	8.4
28	0100	0.78	10.7	2.72	10.7	3.58	10.8	70	3.52	10.1
	0700	1.49	12.2	3.21	11.7	3.42	12.0	102	4.19	11.2
	1300	1.12	13.5	2.82	12.9	3.49	12.0	68	3.78	11.8
	1900	1.50	12.9	3.43	13.5	4.58	13.6	76	5.09	13.4
29	0100	1.02	13.5	2.93	13.5	3.81	13.6	74	4.10	13.4
	0700	1.55	13.5	2.82	12.9	2.99	13.6	68	3.61	14.3
	1300	0.96	12.9	2.27	12.2	2.47	12.0	84	2.50	13.4
	1900	1.15	12.9	1.61	12.2	1.83	12.0	58	1.92	11.8
30	0100	0.85	13.5	1.33	12.2	1.55	13.6	68	1.58	11.8
	0700	0.60	14.3	1.10	12.9	1.19	13.6	64	1.27	11.8
	1300	0.51	13.5	0.97	12.9	1.12	12.0	56	1.22	12.6
	1900	0.56	12.2	1.00	11.7	1.25	13.6	56	1.31	12.6
31	0100	1.01	5.9	1.19	5.7	1.45	13.6	78	1.67	13.4
	0700	1.01	6.1	1.23	6.0	1.42	6.2	50	1.56	6.3
	1300	0.91	6.1	1.11	12.9	1.25	12.0	60	1.41	5.9
	1900	0.95	5.5	0.99	5.4	1.22	5.9	42	1.45	5.9
Mean		0.75	10.0	1.13	10.3	1.24	10.5	75	1.28	9.8
Std dev		0.35	3.2	0.62	2.6	0.75	2.6	20	0.91	2.6

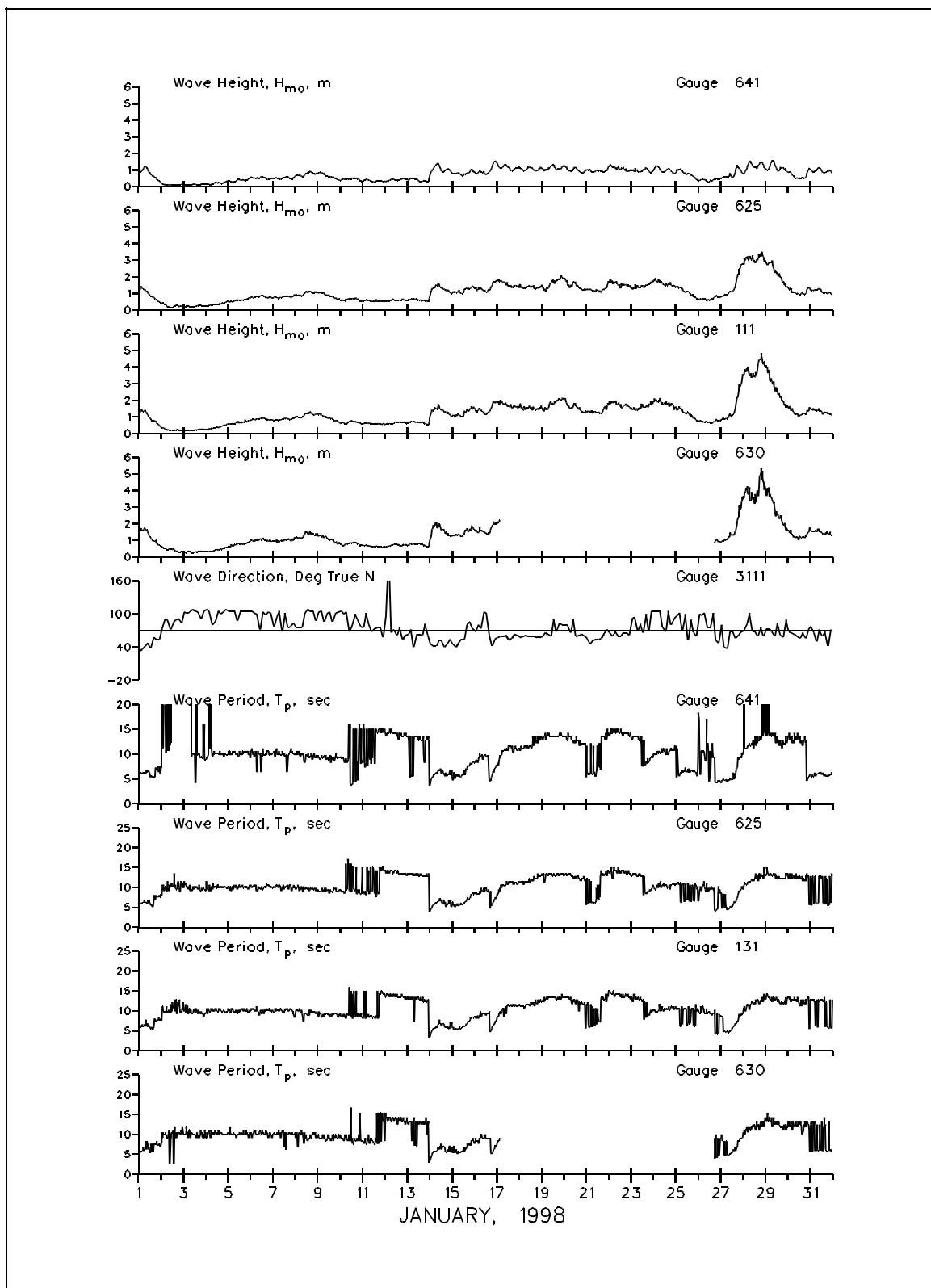


Figure 5. Wave Heights and Periods

4 Current Data

Current data (Table 5) are collected from a Sontek acoustic current meter and by visually observing the movement of small drogues on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier, approximately 12 m offshore (Table 6).

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward). All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the cross-shore and longshore data. Current directions indicate the direction that the current is moving towards. Current data are plotted in Figure 2.

Table 5
Current Meter Data - Gauge 3539

JANUARY 1998																
Day	Time	Cross Long				Cross Long				Cross Long						
		Cross	Long	Shore	Shore	Speed	Dir	Cross	Long	Shore	Shore	Speed	Dir			
1	100	inoperative				1300	-3	10	11	138	22	100	-3	13	13	141
	700					1900					700	-5	13	14	134	
	1300					100	inoperative				1300	-4	9	11	130	
	1900					700					1900	-6	10	13	126	
2	100					1300	-5	24	24	146	23	100	inoperative			
	700					1900	-2	11	12	147	700	-2	3	5	115	
	1300	0	-10	11	338	100	inoperative				1300	inoperative				
	1900					700	-1	5	5	137	1900	0	0	0		
3	100	inoperative				1300	inoperative				24	100	0	-1	2	7
	700					1900	0	-4	5	346	700	-4	12	13	136	
	1300	0	0	0		100	-9	23	25	136	1300	-5	4	7	101	
4	100	inoperative				1300	-6	21	22	143	25	100	-4	18	19	144
	700					1900	-5	15	16	139	700	inoperative				
	1300	0	-2	3	348	100	-5	10	11	130	1300	-7	15	17	134	
	1900					700	-1	1	2	84	1900	-6	16	18	138	
5	100	inoperative				1300	inoperative				26	100	-1	0	2	81
	700					1900	0	2	2	136	700	-3	-2	5	32	
	1300	-1	4	5	134	100	inoperative				1300	-1	-8	9	355	
	1900					700					1900	-1	2	3	109	
6	100	-3	11	12	139	1300	-5	17	18	140	27	100	-2	6	7	133
	700	-3	7	8	131	1900	inoperative				700	inoperative				
	1300	inoperative				100					1300					
	1900	-1	5	5	136	700					1900	-5	10	12	130	
7	100	0	2	2	123	1300	-5	16	17	139	28	100	inoperative			
	700	-1	1	2	107	1900	-4	8	10	129	700	-3	4	6	117	
	1300	-1	0	2	65	100	-3	3	5	105	1300	-10	49	51	147	
	1900	0	3	4	144	700	-4	12	13	140	1900	-35	108	114	142	
8	100	0	-10	11	338	1300	-1	3	3	132	29	100	-24	68	72	140
	700	0	-15	16	345	1900	inoperative				700	-3	25	25	151	
	1300	2	-23	24	334	100	-4	5	7	117	1300	-11	38	40	143	
	1900	3	-3	5	306	700	-3	1	4	88	1900					
9	100	3	-11	12	325	1300	-3	0	4	72	30	100	inoperative			
	700	2	-10	12	329	1900	-4	17	18	143	700					
	1300	4	-13	14	323	100	-7	32	33	146	1300					
	1900					700	-5	19	20	142	1900	-7	15	17	131	
10	100	inoperative				1300	-6	27	28	145	31	100	-7	23	25	140
	700					1900	-6	25	26	145	700					
	1300	-6	11	13	127	21	100	-2	18	18	152	1300	-6	22	23	142
	1900	-5	10	12	128	700	-4	18	18	146	1900	inoperative				
11	100	-1	4	5	133	1300					1900	inoperative				
	700	0	6	6	146	1900					1900					

KEY:

+cross-shore = offshore, cm/sec
- cross-shore = onshore, cm/sec
+longshore = south, cm/sec
-longshore = north, cm/sec
Speed = Resultant speed, cm/sec
Dir = Resultant direction, degrees true north

Table 6
Visually Observed Current Data

Jan 1998												
Day	Pier End				Mid-Surf Zone				Beach			
	Cross Shore	Long Shore	Speed	Dir	Cross Shore	Long Shore	Speed	Dir	Location	Speed	Dir	
1	4	76	76	157	-15	102	103	169	North	70	S	
2	23	-76	80	357	8	-18	20	4	South	18	N	
3	15	-51	53	357	7	-16	17	4	South	11	N	
4	2	-12	13	351	3	-32	32	346	South	14	N	
5	-3	-5	6	309	10	-68	68	349	South	20	N	
6	-5	16	17	177	-13	87	88	169	North	32	S	
7	3	-11	11	357	10	-68	68	349	South	17	N	
8	3	-30	31	346	-18	-122	123	331	South	62	N	
9	14	-30	33	4	-13	-87	88	331	South	38	N	
10	-4	27	27	169	4	-15	15	357	South	14	N	
11	-4	12	12	177	3	-22	22	349	South	18	N	
12	-11	36	37	177	-2	23	24	166	North	21	S	
13	-2	14	14	169	9	-29	30	357	South	33	N	
14	-39	87	95	184	-24	122	124	171	North	122	S	
15	0	0	0		-3	15	15	171	North	17	S	
16	-9	29	30	177	-30	-102	106	323	South	88	N	
17	-11	55	57	171	-26	87	91	177	North	72	S	
18	-6	122	122	163	-13	87	88	169	North	82	S	
19	0	0	0		0	0	0		North	9	N	
20	15	76	78	149	18	61	64	143	North	67	S	
21	7	68	68	154	15	102	103	151	North	64	S	
22	0	0	0		6	61	61	154	North	37	S	
23	-5	-27	27	329	10	-51	52	351	South	32	N	
24	-11	-11	15	295	-35	-87	94	318	North	38	N	
25	15	34	37	136	4	36	36	154	North	19	S	
26	4	-12	12	357	8	38	39	149	North	18	S	
27	-17	29	34	191	-7	47	47	169	North	37	S	
28	15	-76	78	351	-23	-152	154	331	no observation			
29	13	87	88	151	-55	122	134	184	North	91	S	
30	0	0	0		16	13	20	110	North	27	S	
31	9	87	88	154	-15	102	103	169	North	84	S	

KEY:

+cross-shore = offshore, cm/sec
 -cross-shore = onshore, cm/sec
 +longshore = south, cm/sec
 -longshore = north, cm/sec
 Speed = Resultant speed, cm/sec
 Dir = Resultant direction, degrees true north

5 Visual Observations

Visual wave direction measurements (Table 7) of both the primary wave train (i.e. that having the higher wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The pier axis (considered perpendicular to the beach at the FRF) is oriented 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and depth of visibility are also taken daily at the seaward end of the pier. A Bucket Thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The temperature is then read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the depth of visibility.

Table 7
Visual Observations

Jan 1998

Day	Time	Wave Approach Angle at Pier End (degrees from True N)		Surf Zone	Width, m	Water Characteristics at Pier End		
		Primary	Secondary			Temp., C	Density g/cc	Secchi Vis., m
1	1010	40			112	7.5	1.0264	0.9
2	0845	105			54	7.2	1.0264	1.2
3	0900	none visible				8.3	1.0264	2.1
4	0920	95			57	8.9	1.0260	2.1
5	0700	100			96	9.2	1.0261	3.4
6	0810	105			98	9.4	1.0252	2.1
7	0655	110			108	9.4	1.0255	1.5
8	0635	105			202	10.0	1.0254	1.5
9	0640	100			113	10.6	1.0264	0.9
10	1030	80			92	10.3	1.0270	1.5
11	0845	90			59	10.0	1.0262	2.4
12	0610	60			51	8.9	1.0238	1.8
13	0645	65			47	8.9	1.0227	2.1
14	0745	45			157	8.3	1.0237	1.2
15	0645	60			92	8.3	1.0235	1.8
16	0650	100			123	9.2	1.0234	1.5
17	1000	55			160	8.1	1.0222	1.5
18	1005	40			144	8.3	1.0237	0.9
19	1020	75			183	7.8	1.0232	1.5
20	0645	60			177	7.2	1.0236	0.9
21	0620	50			181	7.2	1.0225	1.2
22	0725	60			233	6.7	1.0232	0.9
23	0630	85			185	6.7	1.0214	2.1
24	0845	100	50		210	7.8	1.0254	0.3
25	0924	40			151	7.2	1.0250	0.3
26	0730	50			74	6.7	1.0226	2.1
27	0630	50			33	7.2	1.0220	1.2
28	0700	80			461	7.8	1.0222	0.9
29	0700	60			435	6.7	1.0222	0.9
30	0720	65			75	6.7	1.0238	0.9
31	1005	30			73	6.7	1.0240	0.9

6 Water Levels

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A NOS acoustic tide gauge (Next Generation Water Level Measurement System, NGWLMS) is used to collect water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 6 along with a list of means and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level. Table 8 contains the range, high, low, and mean water level for each 12.42-hr tidal cycle.

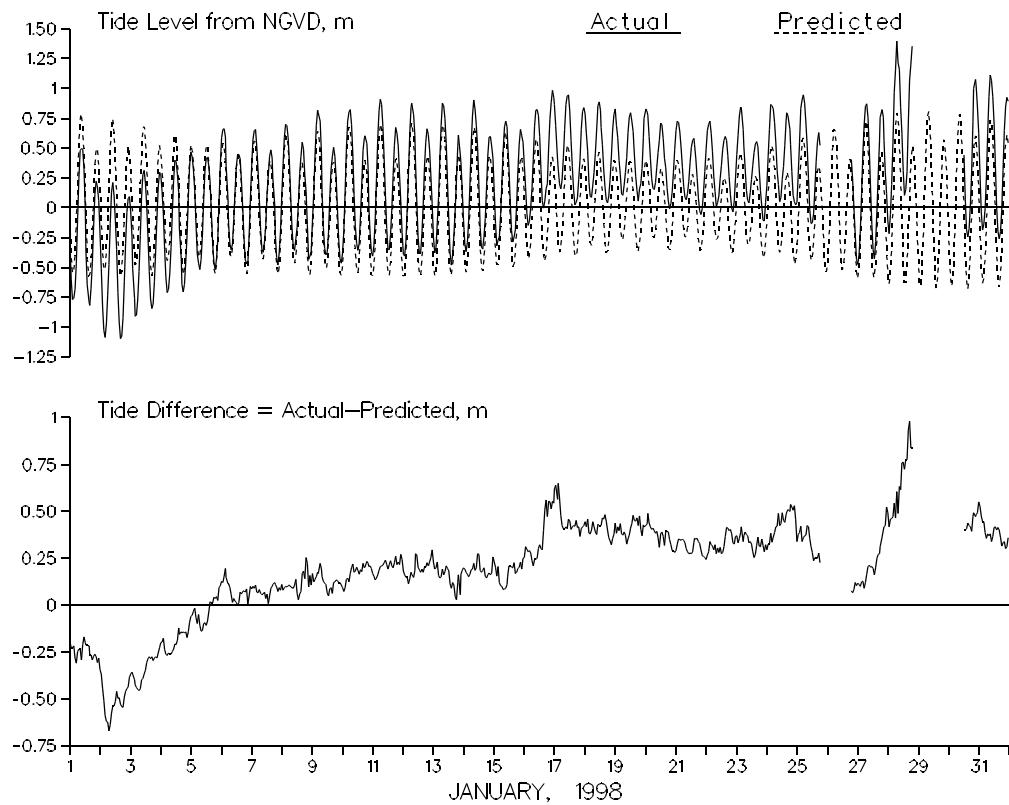


Figure 6. Water Level Variation

Table 8
Water Levels, m NGVD

JAN 1998 Tide Levels																
Day	High			Low			Mean	Range	High			Low			Mean	Range
	Time	m	Day	Time	m	Day	m	m	Day	Time	m	Day	Time	m	m	
1	0930	0.56	1	0230	-0.83	-0.13	1.39	16	2142	1.01	16	1448	-0.05	0.49	1.06	
1	2100	0.22	1	1542	-0.84	-0.30	1.07	17	0948	0.96	17	0448	0.14	0.54	0.83	
2	1000	0.21	2	0400	-1.09	-0.44	1.30	17	2248	0.88	17	1724	0.02	0.42	0.86	
2	2230	0.12	2	1600	-1.10	-0.48	1.22	18	1030	0.94	18	0436	0.05	0.48	0.89	
3	1042	0.33	3	0418	-0.93	-0.30	1.26	18	2342	0.84	18	1754	0.02	0.41	0.82	
3	2318	0.33	3	1724	-0.85	-0.27	1.18	19	1148	0.83	19	0548	0.07	0.44	0.76	
4	1124	0.40	4	0512	-0.73	-0.15	1.13	20	0048	0.85	19	1800	0.06	0.46	0.79	
5	0012	0.47	4	1748	-0.71	-0.12	1.19	20	1148	0.72	20	0630	0.13	0.41	0.59	
5	1306	0.43	5	0700	-0.52	-0.03	0.95	21	0112	0.75	20	1900	-0.01	0.36	0.76	
6	0148	0.70	5	1900	-0.52	0.10	1.22	21	1354	0.59	21	0754	0.05	0.33	0.54	
6	1324	0.47	6	0742	-0.37	0.07	0.83	22	0242	0.73	21	1942	-0.08	0.33	0.80	
7	0254	0.67	6	2012	-0.50	0.10	1.17	22	1512	0.61	22	0742	0.00	0.32	0.61	
7	1454	0.50	7	0848	-0.38	0.06	0.88	23	0306	0.88	22	2054	-0.05	0.41	0.93	
8	0312	0.71	7	2042	-0.50	0.13	1.22	23	1542	0.60	23	0936	-0.01	0.31	0.61	
8	1606	0.58	8	0942	-0.38	0.07	0.97	24	0336	0.95	23	2206	-0.17	0.39	1.12	
9	0436	0.86	8	2242	-0.48	0.21	1.34	24	1630	0.82	24	1018	0.03	0.43	0.79	
9	1700	0.51	9	1130	-0.43	0.05	0.94	25	0536	0.95	24	2230	0.00	0.47	0.95	
10	0442	0.83	9	2300	-0.46	0.18	1.30	25	1648		25	1106	No data this cycle			
10	1754	0.61	10	1154	-0.37	0.13	0.98	26	524		25	2300	No data this cycle			
11	0630	0.92	10	2348	-0.41	0.24	1.33	26	1742		26	1200	No data this cycle			
11	1800	0.67	11	1230	-0.38	0.16	1.05	27	0630	0.88	26	2330	-0.50	0.20	1.38	
12	0624	0.90	12	0024	-0.42	0.24	1.32	27	1906	0.84	27	1300	-0.43	0.23	1.26	
12	1918	0.68	12	1342	-0.43	0.15	1.11	28	0700	1.40	28	0054	-0.23	0.57	1.63	
13	0712	0.89	13	0106	-0.40	0.26	1.29	28	1924		28	1330	No data this cycle			
13	1954	0.61	13	1336	-0.50	0.06	1.11	29	748		29	130	No data this cycle			
14	0754	0.93	14	0136	-0.39	0.27	1.31	29	2012		29	1412	No data this cycle			
14	2024	0.61	14	1406	-0.35	0.14	0.96	30	836		30	218	No data this cycle			
15	0848	0.76	15	0236	-0.33	0.21	1.09	30	2106	1.09	30	1506	-0.26	0.42	1.35	
15	2106	0.69	15	1506	-0.31	0.19	1.00	31	0912	1.13	31	0318	-0.19	0.46	1.32	
16	0924	0.88	16	0342	-0.19	0.34	1.06									

7 Bathymetry

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using a Trimble 4000 SSE GPS for positioning, in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 7 shows the last survey in December and the survey(s) in January on profile line 188, located 517 m south of the pier.

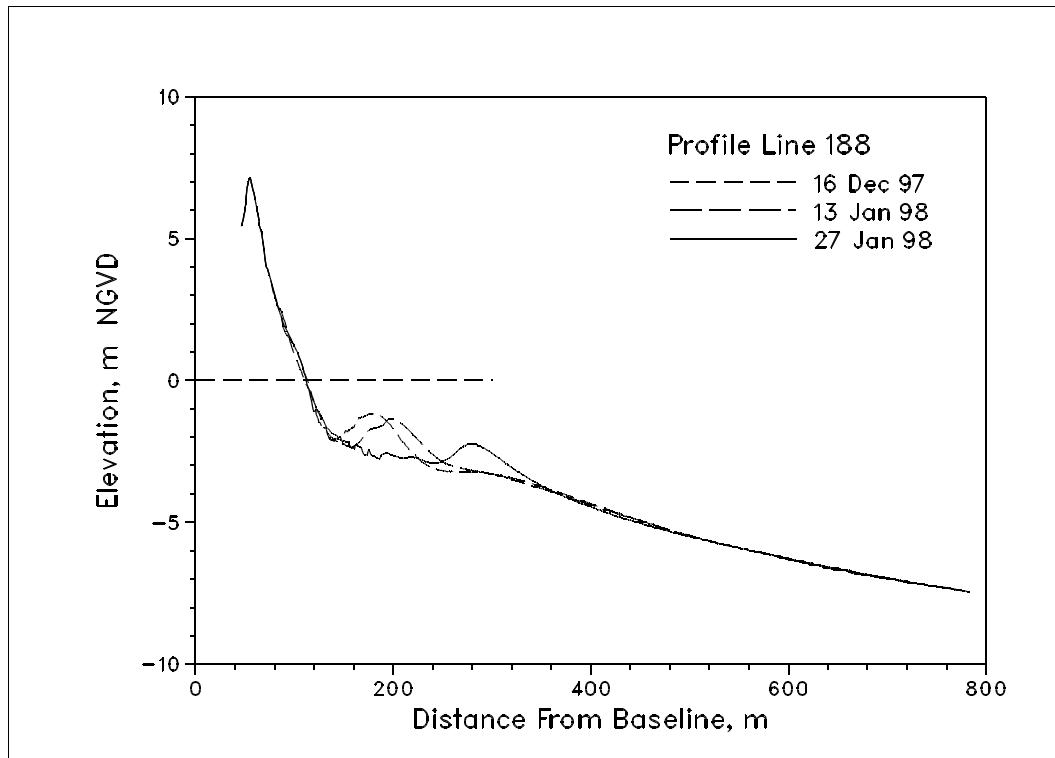


Figure 7. Monthly CRAB Profiles on Profile Line 188.

The profile envelope (Figure 8) reflects the maximum changes that occurred on the profile during 1998. Cross-hatched areas indicate changes to the annual envelope which occurred in January.

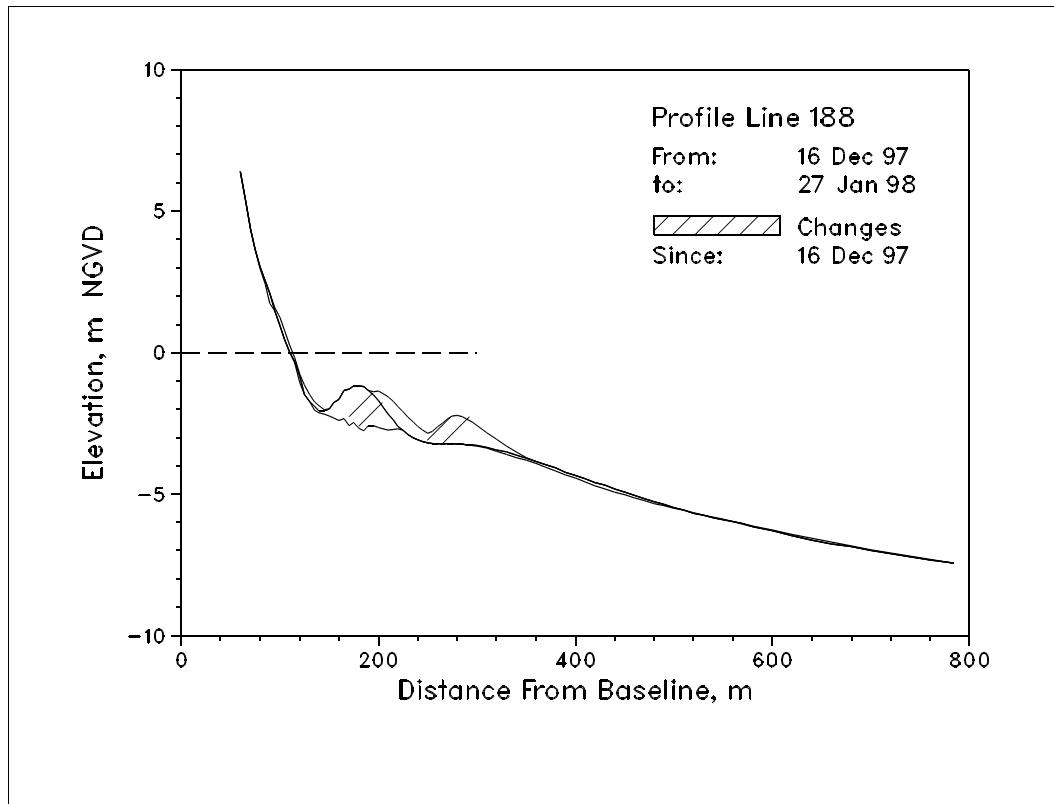


Figure 8. Profile Envelope - Profile Line 188.

B. Bathymetry. Figure 9 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 12 January. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.

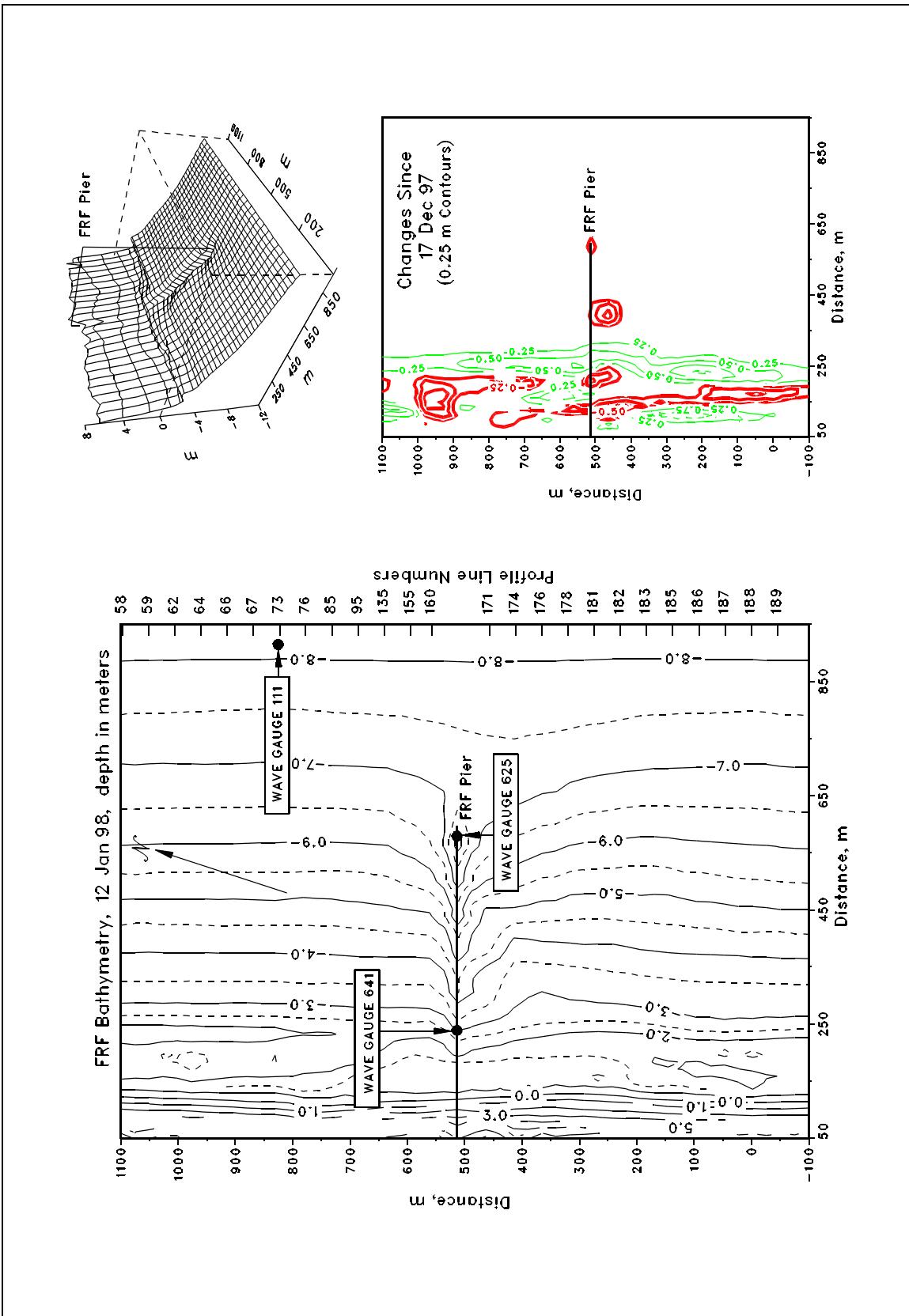


Figure 9. FRF Bathymetry, Depths Relative to NGVD

8 Special Events

A. Storm Data Collection. The following list identifies times when the wave height H_{mo} at the seaward end of the pier exceeded 2 m.

<u>Start</u>	<u>End</u>
27 Jan (1742)	29 Jan (1516)

B. Storm Synopsis.

Northeasterly winds were funneled between a Canadian high pressure system and a low pressure system that traveled along the coast from Georgia. Onshore winds turned offshore as the storm approached the North Carolina coast by the morning of 28 January. Maximum onshore winds (NE) reached 14 m/s at 1900 EST on 27 January. The minimum atmospheric pressure was 991 mb. The maximum H_{mo} , at gauge 630, reached 5.33 m ($T_p=12.5$ s) at 1934 EST on 28 January. There was 56 mm of precipitation.